

FORM NO-1350

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ATTORNEY DOCKET NUMBER
LSP-0015

TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO (if known see 37 C.F.R. 1.5)

10/048095

INTERNATIONAL APPLICATION NO.
PCT/EP00/07152

INTERNATIONAL FILING DATE
26 July 2000

PRIORITY DATE CLAIMED
29 July 1999

TITLE OF INVENTION METHOD FOR POWER OPTIMIZATION IN A VEHICLE/TRAIN HAVING AN EFFICIENCY THAT DEPENDS ON THE OPERATING POINT

APPLICANT(S) FOR DO/EO/US Franke RUDIGER, Peter TERWIESCH, Markus MEYER, Christian KLOSE and Karl-Hermann KETTELER

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) 35 U.S.C. 371(c)(4).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

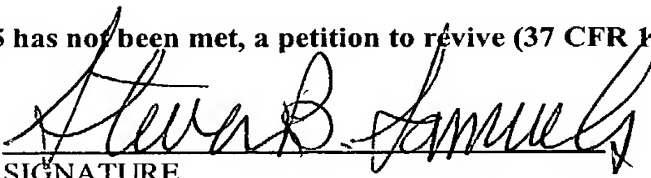
Items 11. to 16. below concern other document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:
- A copy of the Published PCT Application by WIPO under No. WO 01/08959, including the search report.
- A copy of the International Preliminary Examination report, including amended claims 1 and 2 under Article 34.
- An English translation of the Response to the Written Opinion.

EXPRESS MAIL Mailing Label No. EL 899365916 US
Date of Deposit: 24 January 2002

EL899365916US

531 Rec'd PCT/PT 24 JAN 2002

U.S. APPLICATION NO. 10/048095				INTERNATIONAL APPLICATION NO. PCT/EP00/07152		ATTORNEY DOCKET NUMBER LSP-0015	
17. <u> </u> The following fees are submitted: Basic National Fee (37 CFR 1.492(a)(1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO..... \$1,040.00 International preliminary examination fee (37 CFR 1.482 not paid to USPTO but International Search Report has been prepared by the EPO or JPO..... \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO..... \$740.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)..... \$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)..... \$100.00 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT =</div>						CALCULATIONS PTO USE ONLY	
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Claims	Number Filed	Number Extra	Rate				
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Independent Claims	2- 3 =	0	x \$84.00				
Multiple dependent claims(s) (if applicable)			+ \$280.00				
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				Steven B. Samuels NAME			
				37,711 REGISTRATION NUMBER			

DOCKET NO: LSP-0015

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:

Rudiger, et al.

Serial No.: 10/048,095

Group Art Unit: Not Assigned Yet

Filing Date: January 24, 2002

Examiner: Not Assigned Yet

For: METHOD FOR POWER OPTIMIZATION IN VEHICLE/TRAIN HAVING
AN EFFICIENCY THAT DEPENDS ON THE OPERATION POINT

WITHDRAWAL AS ATTORNEY AND
CHANGE OF CORRESPONDENCE AND MAINTENANCE FEE ADDRESS

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531 Rec'd PCT 24 JAN 2002

Method for power optimization in a vehicle/train having
an efficiency that depends on the operating point

Description

5

The invention relates to a method for power optimization in a vehicle/train according to the preamble of claim 1.

10 During the planning of journeys and the drafting of
schedules for rail traffic, time reserves for
unforeseen events and adverse operating conditions are
included in the plans. Since, during real journeys, the
operating conditions are typically more favorable than
15 those assumed during planning, the time reserves
created by this are available for other purposes. A
particularly practical use of the time reserves resides
in the saving of power by means of a suitable travel
mode.

20

Previously known and used methods for power minimization are mostly based on the assumption that a travel mode comprising the constituents maximum acceleration - travel at constant speed - coasting -
25 maximum retardation is optimum in power terms. In this case, the mechanical tractive power which is needed to accelerate the vehicle is minimized. For verification, a linear dynamic train model is used, in particular no account being taken of any term which describes the
30 quadratic relationship between speed and travel resistance.

In DD 255 132 A1, this basic assumption is expanded by subdividing a total route into a number of sections, so
35 that in each section the slope resistance of the route is constant.

- 2 -

In EP 0 467 377 B1, the subdivision of the overall route into a number of sections is introduced in such a way that in each section the permissible maximum speed is constant. The travel mode comprising the
5 constituents maximum acceleration - travel at constant speed - maximum retardation is repeated in each section. Coasting is therefore dispensed with.

EP 0 755 840 A1 does not describe a practical method
10 for power optimization but instead explains a general system structure with which power optimization can also be implemented. A cycle comprising acceleration - travel at constant speed - retardation and braking is listed as an example.

15 The invention is based on the object of specifying an improved method for power optimization with regard to the time reserves included in the planning of a schedule of a vehicle/train.

20 This object is achieved, in conjunction with the preamble, by the features specified in claim 1.

The advantage which can be achieved by the invention is
25 in particular that, by taking into account the dependence of the vehicle efficiency on the operating point in the optimization algorithm, instead of the mechanical tractive power, it is the power primarily used, such as the electrical power in electric rail
30 vehicles, which is minimized.

An advantageous refinement of the invention is identified in the subclaim.

35 Further advantages of the proposed method emerge from the following description.

- 3 -

The invention will be explained in more detail below using the exemplary embodiments illustrated in the drawing, in which:

- 5 Figs. 1, 2 show characteristic maps of the power loss of typical electric locomotives,
- Fig. 3 shows an exemplary speed plot at an assumed constant vehicle efficiency and maximum speed, and
- 10 Fig. 4 shows an exemplary optimum speed plot taking into account the dependence of the vehicle efficiency on the operating point, and maximum speed.
- 15

The vehicle efficiency is the ratio between the tractive power provided - the output power - and the input power needed for this, in particular the electric power, which is drawn by an electric locomotive via a pantograph. The difference between the input power and the output power is the power loss of the vehicle.

The invention provides for the dependence of the efficiency on the operating point to be included in the power optimization or for power optimization with regard to the time reserves included in the planning of a schedule of a vehicle/train, since a calculation with an assumed constant efficiency represents only a poor approximation to the actual optimum. In this case, the problem of power minimization is formulated as a mathematical optimization problem and is solved by a suitable, generally known optimization algorithm.

35 Optimization algorithms which are suitable for the proposed method are known, for example, from Papageorgiou: Optimierung [Optimization], Chapters 10, 19 and in particular 20, Oldenbourg Verlag, 1996.

- 4 -

The dependence of the efficiency on the operating point can be taken into account via a function of the efficiency or the power loss as a function of important
 5 influencing variables, such as in particular the tractive force and/or speed and/or temperature. For this purpose, Figures 1 and 2 show characteristic maps of the power loss of typical electric locomotives. Such a three-dimensional characteristic map of the power
 10 loss as a function of the tractive force and the speed is a typical option for representing the dependence of the efficiency on the operating point.

Fig. 3 shows, as a traveling diagram, an exemplary
 15 distance/speed plot - see the continuous curve - with an assumed constant vehicle efficiency and maximum speed in the individual route sections - see the dashed curve. The travel mode illustrated is composed of the known constituents, these being used repeatedly in each
 20 subsection with constant speed limitation. These known constituents are essentially maximum acceleration, coasting and braking in the first section, followed by "travel at constant speed" in the slow-travel section, followed by maximum acceleration and the change between
 25 coasting and braking to a standstill.

Fig. 4 shows, in comparison with this, as a travel diagram (and determined in accordance with the characteristic map according to Fig. 1) an exemplary
 30 optimum speed plot - see continuous curve - taking into account the dependence of the vehicle efficiency on the operating point and maximum speed - see the dashed curve. The optimum travel mode illustrated differs considerably from travel modes which can be determined
 35 with previously known methods (see Fig. 3). In particular, in the exemplary embodiment illustrated, use is made of reduced acceleration, which merges smoothly into the braking.

Patent Claims

1. A method for the power-optimal travel mode of a vehicle/train, the time reserves for unforeseen events and adverse operating conditions included when planning schedules being available for saving power by means of a power-optimal travel mode, wherein the dependence of the vehicle efficiency, defined as the quotient of the tractive power provided - the output power - and the input power needed for this purpose, on the tractive force and/or speed and/or temperature is used for the purpose of optimizing the power with regard to the time reserves.
2. A method for the power-optimal travel mode of a vehicle/train, the time reserves for unforeseen events and adverse operating conditions included when planning schedules being available for saving power by means of a power-optimal travel mode, wherein the dependence of the vehicle power loss, defined as the difference between the input and the output power, on the tractive force and/or speed and/or temperature is used for the purpose of optimizing the power with regard to the time reserves.

Method for power optimization in a vehicle/train having
an efficiency that depends on the operating point

Abstract

A method for power optimization in a vehicle/train, using time reserves included when planning a schedule, is proposed. In order to achieve a power-saving travel mode with the aid of an optimization algorithm, the dependence of the vehicle efficiency or the power loss on the operating point is taken into account.

Relevant figure: Fig. 1

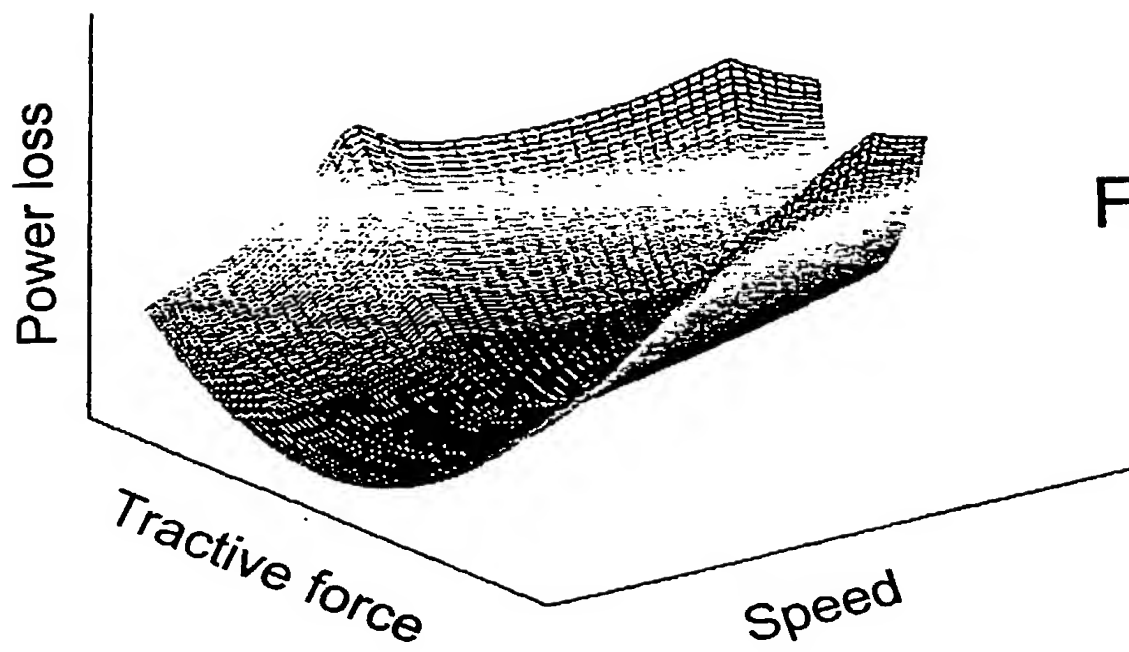


Fig. 1

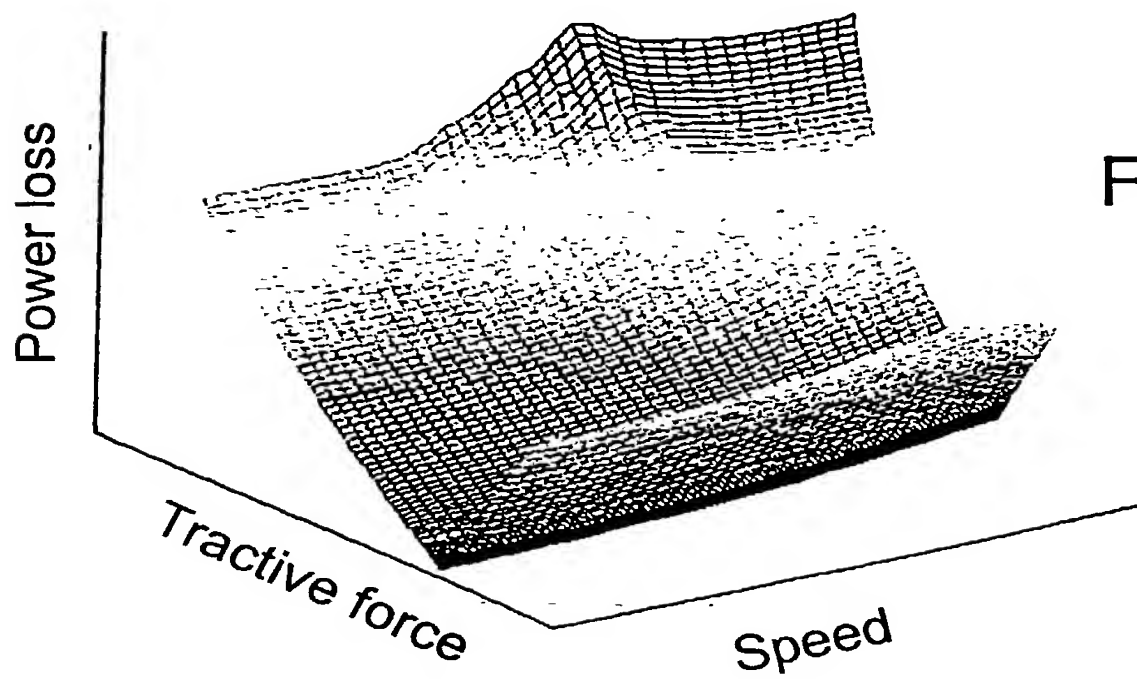


Fig. 2

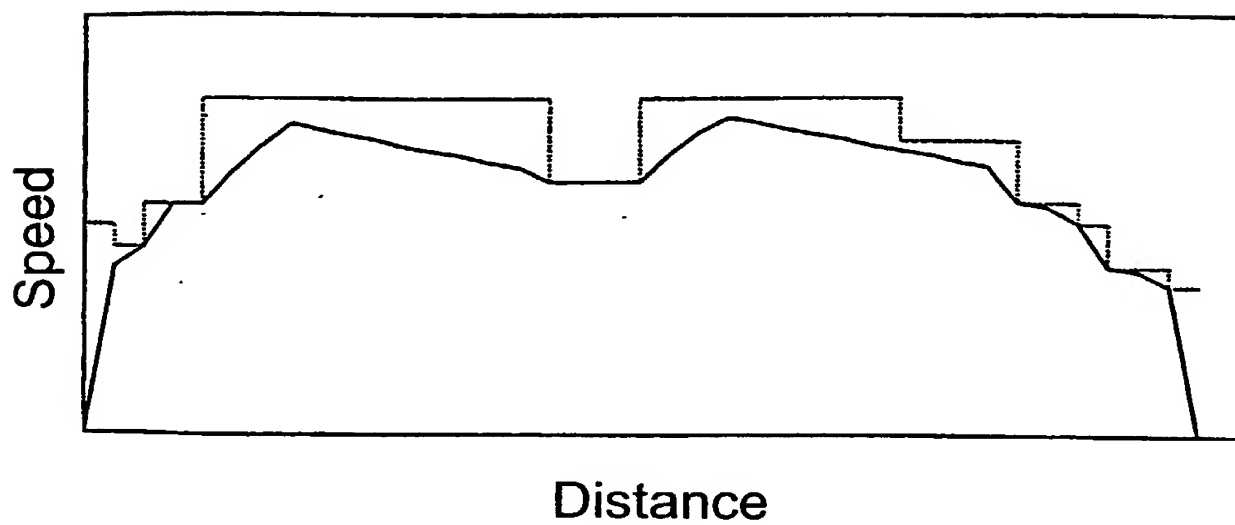


Fig. 3 (Prior art)

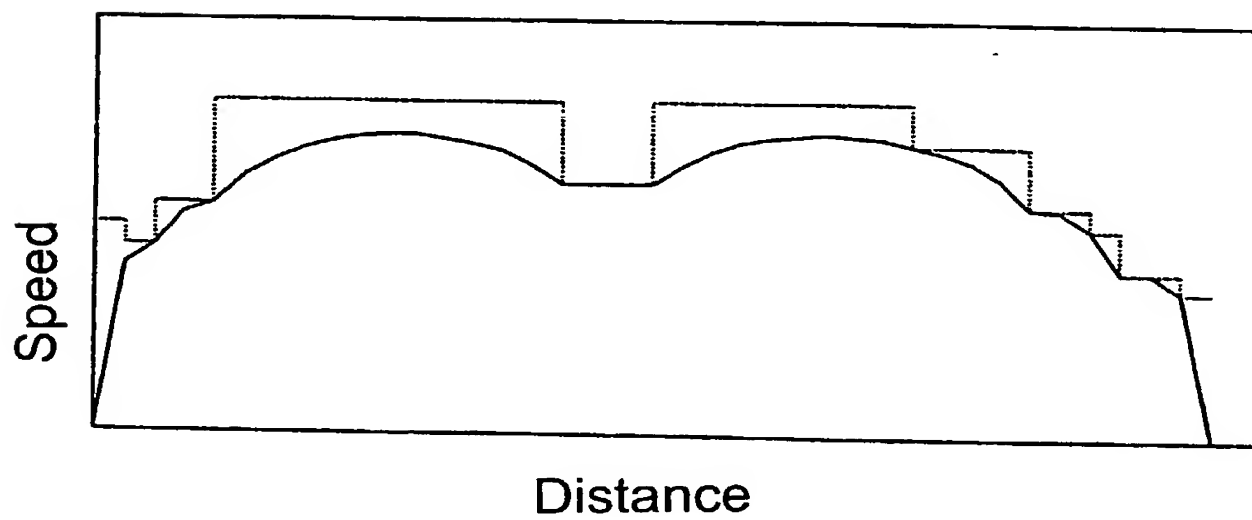


Fig. 4

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the specification of which is attached hereto unless the
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☒ wurde angemeldet am / was filed on: **26 July 2000**

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und am / and was amended on (if applicable) **3 September 2001** abgeändert (falls zutreffend).

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3100444005 00727012

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Prior Foreign Applications / Frühere ausländische Anmeldungen

(Number)
(Nummer)

DE 199 35 351.4

(Country)
(Land)

Germany

(Filing Date: day/month/year)
(Anmeldetag : tag/monat/jahr)

29 July 1999

Priority Not Claimed
Priorität nicht beansprucht

☐☐

Ich beanspruche hiermit Prioritätsvorteile unter Title 35, US-Code, § 119(e) aller US-Hilfsanmeldungen wie unten aufgezählt.

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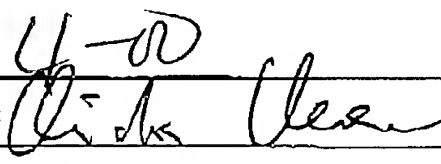
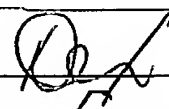
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